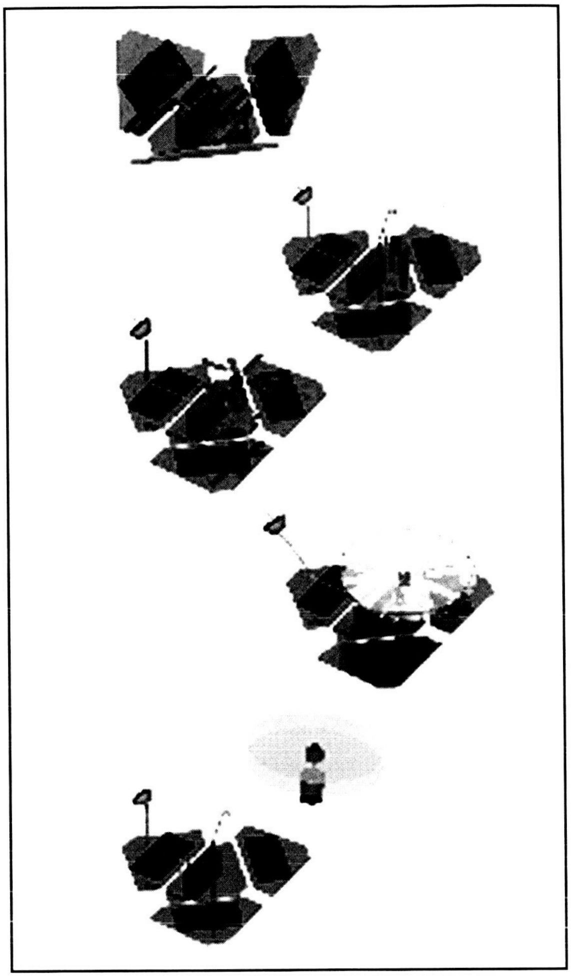

Fig. 1. National Mars Coaxial Helicopter.

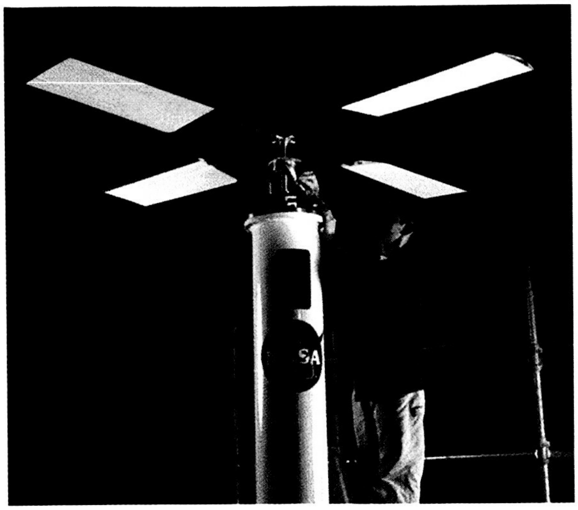

Fig. 2. Rotor and hover test stand for testing in simulated Mars atmosphere.

A baseline rotor and hover test stand for testing at Mars atmospheric densities has been developed (fig. 2). Initial proof-of-concept rotor hover testing will commence before the end of FY01.

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Ultrafast Beam Self-Switching by Using Coupled VCSELs

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The objective of this work was to develop directional beam switching through the use of two coupled vertical-cavity surface-emitting lasers (VCSELs). The simulation results show directional switching at a speed of about 40 gigahertz (GHz) and between directions about 8 degrees apart.

Dynamic beam switching of VCSELs has important applications for switching and routing in optical interconnect networks. VCSEL arrays of various kinds have been quite extensively researched for tailoring and engineering near- and far-field patterns. We propose a new method of directional beam switching by using two coupled VCSELs as follows. When two VCSELs are coupled by a small inter-VCSEL separation, and biased at the same steady current near threshold, then the resulting light output is dynamic at an extremely high frequency. As shown in the figure, the resulting far-field pattern shows two lobes that are oscillating out of phase and producing beam switching.

Our model was based on an approximation to the semiconductor Maxwell-Bloch equations. The time evolution of the spatial profiles of the laser and carrier density is obtained by using a finite-difference algorithm to solve the coupled partial differential equations that govern their evolution. The algorithm is fairly general; it can handle devices with one or multiple active regions of any shapes, which can be either gain- or index-guided. There is no a priori assumption about the type or number of modes. The physical modeling includes the effects of nonlinear carrier dependence and dispersion, with respect to wavelength, on the optical gain and refractive index. The modeling of the optical susceptibility is based on first-principles and includes device details such as a quantum-well structure and many-body effects. Temporal dynamics as fast as on a scale of a picosecond can be resolved.

The simulation is for coupled VCSELs operating at 980 nanometers with circular current apertures of 5.6 microns in diameter. The two VCSELs are operating near threshold current injection. The figure shows snapshots of the far-field beam-intensity patterns, from a top view, within a cycle of modulation. The boundary between the white and black regions is the value of intensity halfway between the maximum and minimum values of one of the peaks during a cycle of oscillation. As shown, the higher far-field peak oscillates between two directions separated by about 8 degrees, and the frequency is at 42 GHz. The near-field pattern also showed two spots that were oscillating in relative intensity. However, they were oscillating 90 degrees out of phase with respect to the oscillation in the far-field pattern.

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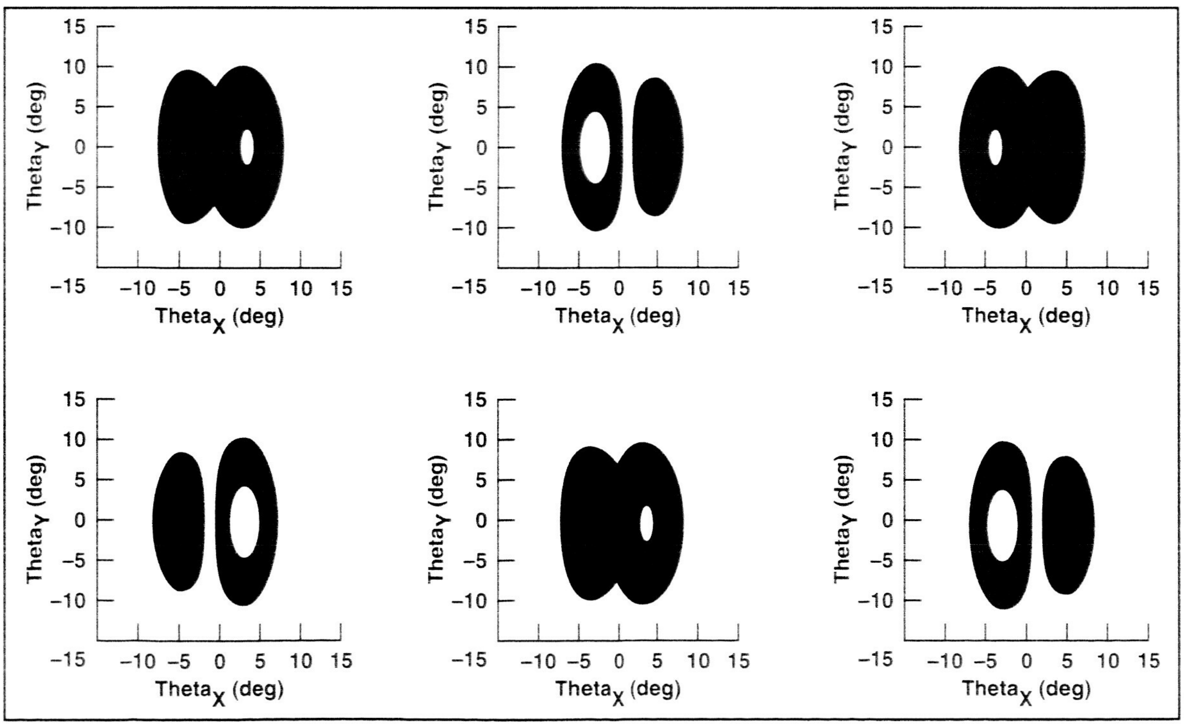

Fig. 1. A top view of the far-field beam intensity over one and one-half cycles of beam switching. The switching speed is 42 GHz and the beams are separated by about 8 degrees.